DOCUMENT RESUME

ED 152 575 SE 024 141

TITLE	Manhole Safety. Training Module 3.330.1.77.
INSTITUTION	Kirkwood Community Coll., Cedar Rapids, Iowa.
SPONS AGENCY	Department of Labor, Washington, D.C.; Iowa State Dept. of Environmental Quality, Des Moines.
PUB DATE	Sep 77
NOTE	37p.; For related documents, see SE 024 138-165; Pages 15-26 - illustrations of how to block-off traffic when working on road - removed prior to being shipped to EDRS for filming due to copyright restrictions
EDRS PRICE	MF-$0.83 HC-$2.06 Plus Postage.
DESCRIPTORS	*Instructional Materials; *Post Secondary Education; *Safety; Secondary Education; *Teaching Guides; Units of Study
IDENTIFIERS	*Sewers; *Waste Water Collection; Waste Water Treatment

ABSTRACT

This document is an instructional module package prepared in objective form for use by an instructor familiar with the use of safety equipment to prevent accidents, injury and loss of life to personnel while inspecting or working in sewer manholes or in confined areas of wastewater treatment plant. Included are objectives, instructor guides, student handouts, and transparency masters. This module considers purposes and types of manholes, a safety checklist, and proper use of safety equipment. (Author/RH)

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ED152575

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MANHOLE SAFETY

Training Module 3.330.1.77

Prepared for the

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The publication of these training materials was financially aided through a contract between the Iowa Department of Environmental Quality and the Office of Planning and Programming, using funds available under the Comprehensive Employment and Training Act of 1973. However, the opinions expressed herein do not necessarily reflect the position or policy of the U. S. Department of Labor, and no official endorsement by the U. S. Department of Labor should be inferred.

September, 1977

SE 024 141

SUMMARY

Module No:	Module Title:
	Manhole Safety
Approx. Time:	Submodule Title:
8 hours	1. Manholes 2. Safety checklist 3. Safety

Overall Objectives:

After successful completion of the course, the student will:

1. Be able to identify the seven (7) common purposes for using manholes.
2. Be able to identify the four (4) basic types of manholes.
3. Be able to describe the six (6) most common dangers found in manholes.
4. Be able to describe the causes of dangerous conditions in manholes.
5. Be able to identify the proper safety equipment to be used when working in manholes.
6. Be able to describe the principles of operation for manhole safety equipment.

Instructional Aids:

Handouts #1 - Manhole Safety
#2 - Manhole Safety Checklist
#3 - Manhole Safety Manual
#4 - Personal Protective Equipment Checklist
#5 - Respiratory Protective Equipment
Transparancy #1
Safety Equipment

Instructional Approach:

Discussion
Lecture
Demonstration

References:

1. WPCF Manual of Practice #9, Design and Construction of Sanitary and Storm Sewers.
2. Manual of Wastewater Operations - Texas.
3. Manhole Safety - A working manual and Information Digest - Iowa State Hygienic Lab (Handout #3).
4. Equipment Manufacturers Literature (may vary depending on type of equipment used).

Class Assignments:

1. Read handouts
2. Sketch types of manholes
3. Participate in class discussion
4. Observe demonstration

Module No:	Module Title: Manhole Safety Practices
	Submodule Title: Manholes
Approx. Time: ½ hour	Topic: Purpose of Manholes

Objectives:

Students shall be able to identify the seven (7) common purposes for using manholes.

Instructional Aids:

Handout #1

Instructional Approach:

Discussion

References:

WPCF Manual of Practice #9, Design and Construction of Sanitary and Storm Sewers.

Class Assignments:

Read handout

Module No:	Module Title: Manhole Safety Practices
	Submodule Title: Manholes
Approx. Time: ½ hour	Topic: Types of Manholes

Objectives:

Students will identify the four (4) basic types of manholes.

Instructional Aids:

(AV) Overhead transparancies

Instructional Approach:

Discussion
Demonstration
Exercise

References:

EPCF Manual of Practice #9, Design and Construction of Sanitary and Storm Sewers.

Class Assignments:

Students will sketch the (4) four basic types of manholes as illustrated by instructor.

Module No:	Module Title: Manhole Safety Practices
	Submodule Title: Manholes
Approx. Time: 1 hour	Topic: Common Dangers Found in Manholes

Objectives:

Student shall be able to identify the six common dangers found in manholes, and the causes of these dangerous conditions.

Instructional Aids:

Handout

Instructional Approach:

Discussion
Exercise

References:

WPCF Manual of Practice #1 (Safety), Manual of Practice #9, Design and Construction of Sanitary and Storm Sewers.

Manual of Wastewater Operations - Texas

Class Assignments:

1. Read handout
2. Participate in class discussion

MANHOLE SAFETY - Handout #1

A. Purpose of manholes

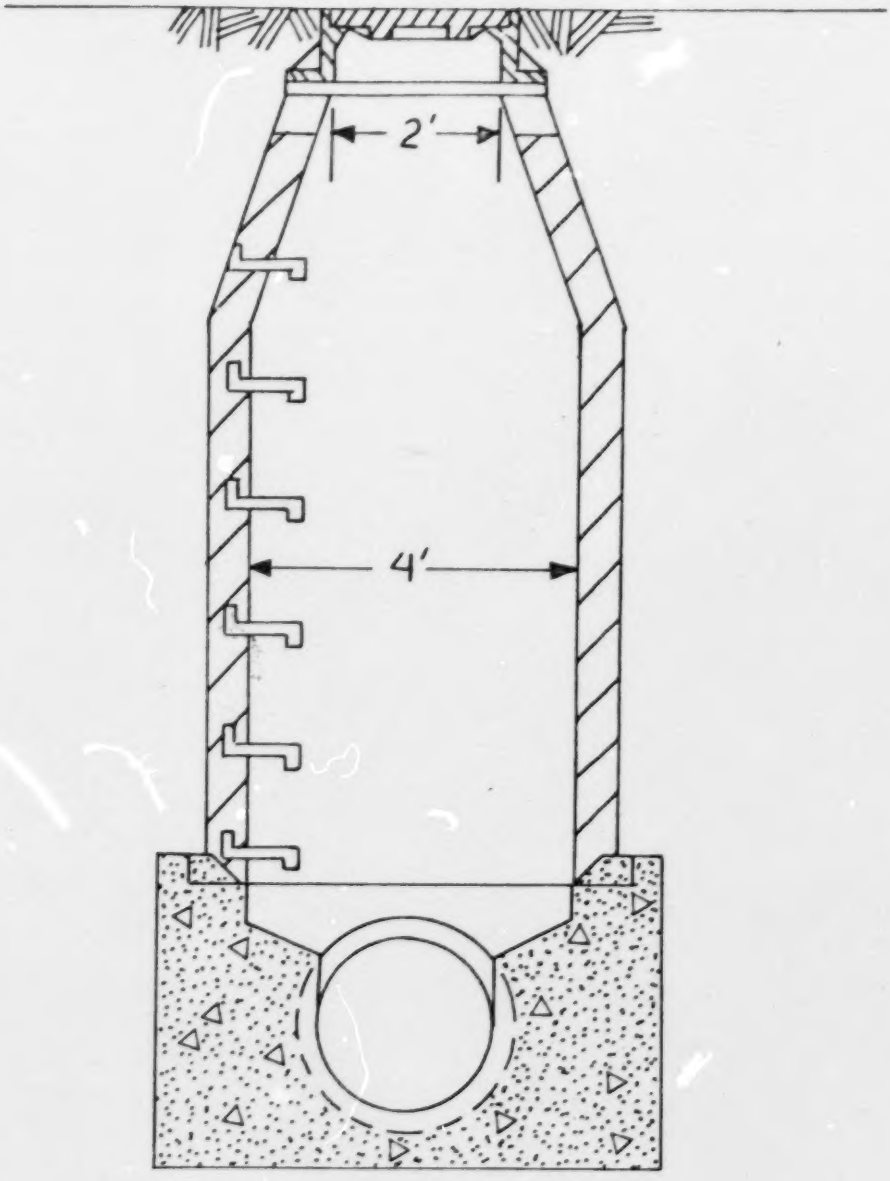
1. Change in direction of sewer lines
2. Change in grade of sewer lines
3. Inspection and cleaning access to pipes
4. Ventilation of sewers
5. In treatment plant they may be used for access to underground tanks, pump stations, wet wells and tunnels.
6. Where two or more sewers connect
7. Where unequal size lines join

B. Types of manholes

1. Standard - 5 feet deep or more, most common
2. Shallow - less than 5 feet deep
3. Drop - Where difference in invert elevations is greater than 1.5 feet
4. Pressure - Where high flow level exists, cover is gasketed and bolted

C. Common dangers found in Manholes

1. Heavy covers - typical street cover weighs 160 pounds, use proper lifting technique.
2. Loose or corroded steps in manhole
3. Surges in flow of sewage - if possible divert upstream flow temporarily.
4. Oxygen deficiency - very common
5. Explosive gases - methane, gasoline
6. Toxic gases - Hydrogen sulfide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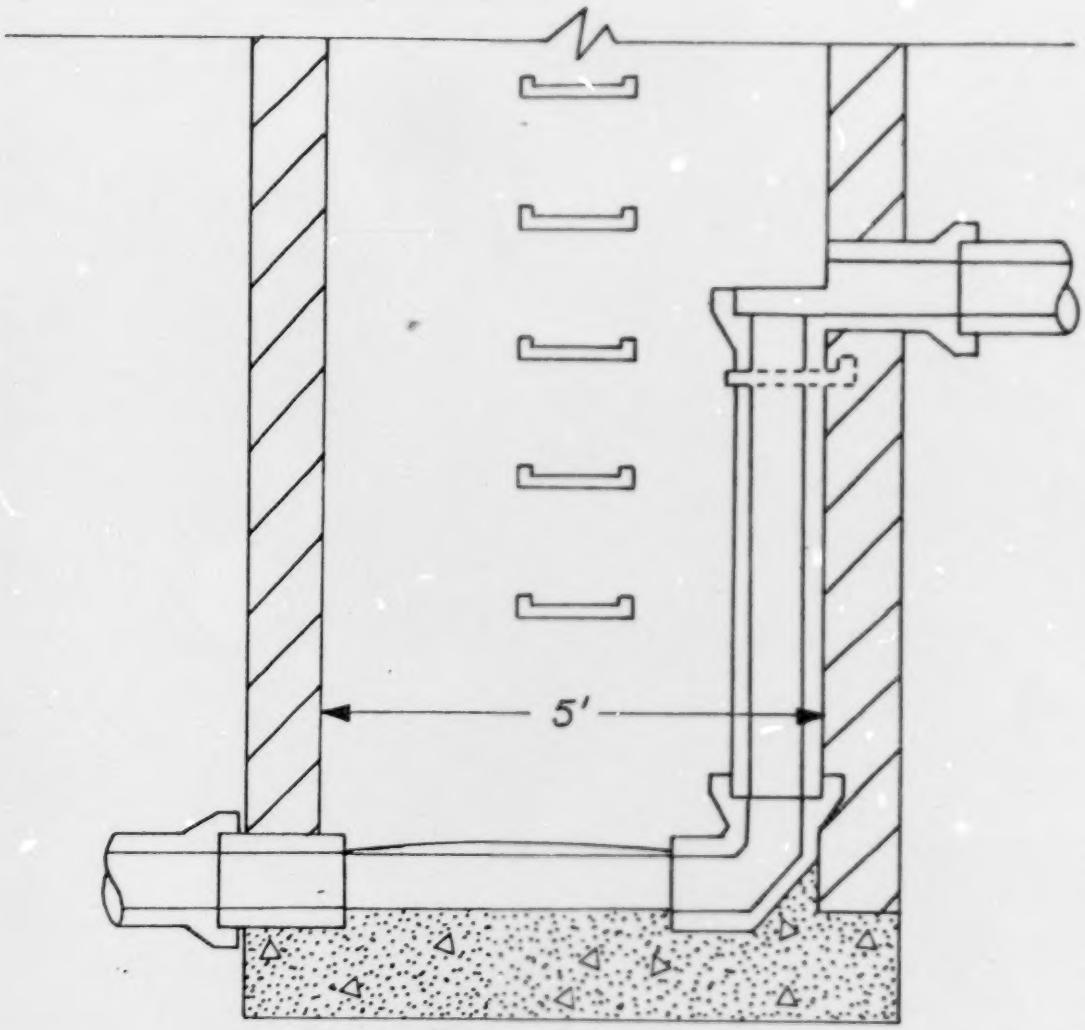
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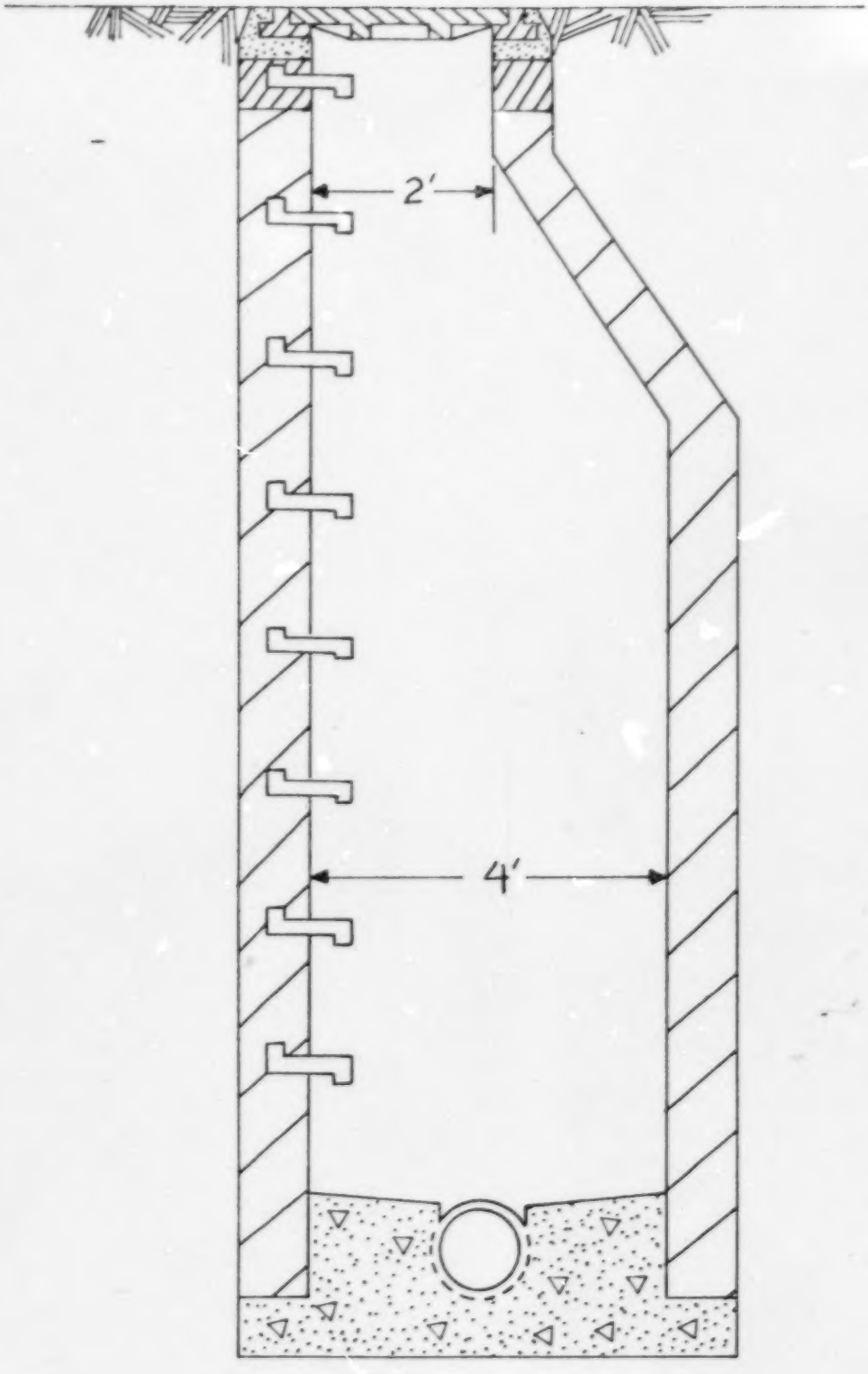
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D. Causes of dangerous conditions cont.

1. Low flow velocity - poor design
2. Low flow velocity - stoppage in line low flow velocity can allow the sewage to become septic with the formation of H_2S, CH_4 and other gases as a result, also can lead to oxygen deficiency as result of oxygen demand of sewage. If possible avoid cleaning lines upstream from the manhole you are working in - when unplugged, large flow surge is possible.
3. Poor ventilation - solid manhole covers, long sewer runs (over 400') between manholes blocked lines, also undersized lines which flow full causing sewer to flow full, can all lead to poor ventilation of lines and manholes. Solid covers are preferred because they will not admit runoff from rain etc. Also less danger from vandals throwing debris into holes.
4. Toxic gases - toxic gases other than the ones normally expected (H_2S, CH_4 etc.) may occur. CO will be primarily from exhaust of combustion process, CO_2 in excess of normal valves may be encountered. Cl_2 from prechlorination or wash down after a Cl_2 leak. Also, industrial processes may discharge wastes which can produce gases other than the types normally encountered in manholes. Danger of CO buildup from using engine driven blowers with suction lines placed downwind of exhaust.

5. Hot weather can greatly accelerate the bacterial action which can produce septic sewage and the formation of related gases. Also hot weather can cause the sewage to release gases normally dissolved in the liquid at cooler temperatures. Dissolved O_2 in sewage will drop in warm weather thus leading to move rapid putrification of sewage and greater tendency for septicity.
6. Explosive gases - CH_4 (methane) may occur if the sewage is septic and in an advanced anaerobic condition.

Module No:	Module Title: Manhole Safety Practices
	Submodule Title: Safety Practices
Approx. Time: 2 Hours	Topic: Safety Checklist

Objectives:

Given a manhole safety checklist and safety manual the student will be able to explain each of the seventeen (17) items.

Instructional Aids:

Handout #2 - Manhole Safety Checklist
Handout #3 - Manhole Safety Manual
Handout #4 - Personal Protective Equipment Checklist
Handout #5 - Respiratory Protective Equipment

Instructional Approach:

Discussion - Lecture

References:

Manhole Safety - A working manual and information digest
Iowa State Hygenic Lab

Class Assignments:

Read handout
Participate in discussion

MANHOLE SAFETY CHECKLIST - Handout #2

1. Supervision - Buddy System
2. Traffic control - cones, barricades
3. Blower - 200 cfm - 30 air changes/hour
4. Hazardous locations - Unit #1
5. Gas tests
6. Personal protection - see handout on equipment
7. Safety harness - manhole, parachute, write 9/16" lines
8. Ladder - narrow OSHA
9. Electrical - ground fault interrupters explosion proof
10. Tools & work - non sparking
11. Physical agents - noise, heat, light
12. Fire protection - extinguishers
13. Personal hygiene
14. Medical - doctors, hospital
15. Housekeeping - cleanup, inspection
16. Final checks - supervisor - training for crew
17. Accident reports - OSHA

MANHOLE SAFETY - Handout #3

1. Supervision - Buddy

   An attendant(s) should, without exception, be on the surface or outside when a manhole, vessel, or chamber is entered. During the workman's residence, the man outside should keep the worker in view and/or in continual communication. Where conditions indicate that the man inside should use a lifeline, the other shall be on that rope at all times. Facilities to withdraw the worker shall also be provided. Other available workers and winches as examples.

2. Traffic Control

   This refers to the necessary warning signals, barricades (striped), cones holeguarding, fluorescent vests, needed gear and procedures for traffic and work control. These items are referenced, but not enlarged upon in this report. "NO SMOKING" signs and the practice of not smoking may be required.

3. Blower

   A. One blower for each hole should normally be used for every entry. This may include some locations more shallow than five feet. It should include locations five to ten feet in depth. For holes deeper than ten feet, it should be used with tests; see paragraphs 4 and 5 of this report. The use of a blower is indicated for brief entries and holes where no sewage or material with oxygen demand is present. Some entries are made more appropriately with a self-contained or supplied air system.

PAGES 15-26 - illustrations of how to block-off traffic when working on road - REMOVED PRIOR TO BEING SHIPPED TO EDRS FOR FILMING DUE TO COPYRIGHT RESTRICTIONS.

B. The blower should operate continuously during work, providing 30 changes of air per hour for the effective volume entered (see airflow paragraph 5). A minimum of 12 changes of air should occur before entry. Where extensive amounts of stagnant organic matter, for example, sewage is exposed, hydrogen sulfide and other tests should be made to be sure that a safe atmosphere exists. Gas can, in some cases, be given off at a rate that the usual ventilation is not adequate.

C. The direction of airflow should be noted. This can be visualized by a puff of powder, for example, starch or talc, or a chemically generated smoke. A fire generated smoke may be a serious risk. Changes in airflow during the course of work must be noted.

1. If air moves into the confinement, this may assist ventilation.
2. If air is stagnant, air contamination accumulates and oxygen may be depleted.
3. If air is moving out of the confinement, impurities may be brought from other sections of the sewer. It is important to place the blower discharge where it will be effective. Adequate capacity is also required.

D. Keep exhaust funes out of the blower intake. Though this is an obvious hazard, the condition has been observed, and must therefore be consciously considered.

4. Hazardous Locations

The ones listed require precautions in addition to the blower and supervision. A minimum of explosibility, oxygen, and normally hydrogen sulfide, should be made in the following:

A. All sewers and manholes more than 10 feet deep.

B. Any tightly covered pit, tank or valve chamber, regardless of depth (solid covers).

C. Deep tanks, sludge digestion tanks, and pump suction wells.

D. All large trunk sewers.

E. Sewers located in the vicinity of gas mains or gasoline storage tanks.

F. Sewers from industrial areas.

G. Sewers on flat grades or constrictions where solids may settle and decompose.

H. Sewers with manholes over 300 feet apart.

5. Gas Tests

Use an instrument that works, and for which the calibration is verified.

Both field and laboratory tests should be made on test instruments to insure proper operation. This includes that they are free of leaks, have the proper flow rate, and give the correct reading. Some of these tests (e.g. leak test) should be made frequently in the field. Other tests may have to be made in the shop, office, or in a laboratory. Verification of a few points of operation may be adequate. Test contaminated air solutions can now be purchased from suppliers, or prepared in municipal laboratories or consultants laboratories. Refer to the supplier's manual for information. References list some suppliers of these devices, most of which are already distributed in Iowa by a safety equipment supplier. Several vapors or gases that may be encountered can be tested. The "pilot" ones are listed below for usual tests, though others may be present. Long probes or tubes for sampling are desirable so that tests can be made before entry, perhaps through

the holes in the cover. Note the airflow into or out of the manhole. If it is necessary to have a man enter the chamber to test, a safety harness (see Item 7 this report) shall be mandatory.

No OSHA reference is given to directly require tests of sewers to be made, but after an accident you will (we understand) be required to show proof that these had been made. A need for such measurements is illustrated in a series of accidents and standards (including the 1st edition of this report) in most cases documented before the OSHA law.

Get out of the sewer if you feel dizzy, sleepy, nauseated, if it becomes hard to breath, or if water starts rising.

A. Explosibility

The combustible gas indicator to measure "explosibility" should provide a first test. It should be a reliable model, zeroed in the field before using insensitive to high humidity, and verified for proper readout occasionally with a "standard" gas.

The usual model reads from 0 to 100 percent of the Lower Explosive Limit (LEL) to detect methane and gasoline, etc. at explosive levels. New models should be considered that read full-scale. 0 to 1,000 parts per million (ppm) (12,000 ppm is LEL of toluol) sensitive scale provide important information on many materials at their toxic levels. OSHA inspectors are using this instrumentation with sensitive scales. (Communications not referenced). Mine type lamp detectors have not found favor in sewage works.

B. Oxygen

18% minimum oxygen is necessary before entry. Since oxygen is both absorbed by the biological demand (BOD) and displaced by other gases (e.g. carbon dioxide and methane) this check should be routine. In low oxygen, flammable gases will not properly register as combustible on indicators.

Instruments should be chosen for long-term reliability. Some sensor cells must be reconditioned several times per year, may be expensive, and variable. The cell should NOT foul on hydrogen sulfide; a common gas in sewage problems and a common failing of several types of cells.

C. Hydrogen Sulfide

Hydrogen Sulfide should be suspected and tested at EVERY location where sewage or organic matter is present and subject to bacterial action. It is usually prevalent where sewage has been stagnant even a short time.

As it has an anesthetic effect on the ability to small, it seems odorless - or becomes so. It has been observed to generate rapidly enough that blowers do not completely handle it. Rechecks should be made frequently during work, where indicated.

1,000 to 2,000 ppm results in unconsciousness with early cessation of respiration and death in a relatively few minutes. Five hundred to 700 ppm results in loss of consciousness and possibly death in 30 minutes to one hour. Some irritation was reported as low as 10 ppm.

A wide range of instrumentation is available to test the H_2S from the classical chemistry laboratory paper soaked in lead acetate, through detector tubes and modern continuous detectors. A fixed rate of airflow over the detector is required for precise measurement. The automatic devices are recommended for use in some plant operations. Operation of the sensing devices should be verified frequently. Leaks, incorrect flow rates (even reverse flow) and other difficulties have been observed with various models.

D. Sewer Gas

Is a general term describing a wide range of possible mixtures. On-site control can often be made by testing of the previously mentioned gases as "pilot" gases. These additional constituents may sometimes complicate the problem, or give difficulty independently.

1. Carbon Dioxide - CO_2, TLV = 5,000 ppm

   This gas has been found in manholes; with and without sewage, with and without an oxygen deficiency. It increases the respiration rate and gives an oppressive feeling.

2. Carbon Monoxide - CO, TLV = 50 ppm

   The usual source is from motor exhausts either from the blower air or from a remote area. Tests should be made where indicated and often simply as a good precaution.

   Instrumentation is typically by detector tubes or instrumentation including some sophisticated types. The OSHA teams normally, we understand, have applied detector tubes, or hand-held instruments such as hopcolite or newer detector devices. Calibration gases are now available to verify the measurement.

This gas standard is recommended in addition to battery, leak, flow, and other tests.

3. Other sewer gases

A host of other gases may be found in sewage, either as a product of putrefaction or in specific areas of a plant from auxiliary treatment such as disinfection by chlorine or deodorizing by ozone. Innumerable gases may be present, which are not listed here, but would be ideally controlled by good ventilation and "pilot" test of the appropriate major constituents.

Test devices vary widely from detector tubes, field direct reading, to sophisticated continuous measuring instruments. The choice depends on the characteristics of the gas, the need to test repetitively, calibration requirements, etc.

Ammonia, NH_3 - TLV = 50 ppm

Methane, CH_4 - Simple asphyxiant, no TLV, 18% O_2 minimum explosive.

Organic Acids e.g. Acetic Acid - TLV = 10 ppm.

Phosphine - TLV = 0.3 ppm

Chlorine - TLV = 1.0 ppm

Ozone - TLV = 0.3 ppm

Nitrogen Dioxide - TLV = 5 ppm Ceiling

E. Industrial

A wide range of materials including gases may be emitted from industrial processes. Their source and nature should be traced for a good base on which to resolve the problem. Toxic, explosive, radioactive materials are examples. The examples listed do have a

volatile component and have been observed in Iowa. The cyanide was from plating wastes, the gasoline was from a service station leak.

Hydrogen cyanide - TLV = 10 ppm (is skin absorbable)

Gasoline - TLV = Approximately 500 ppm. This is an explosive mixture for which specific components (e.g. tetraethyl lead and aromatics) may lower the TLV significantly.

6. Personal Protection

Personal protective devices are "personal" inasmuch as they must fit specifically the individual that wears the device(s). Especially check fit to individual, proper choice (gases are NOT filtered by dust cartridges); do several items work when worn together, or do they fall off. Full-face self-contained supplied air respirators may be considered.

Through the OSHA philosophy correctly expects engineering design to correct problems in work areas, some need for protective gear will always be required for field operations. Safety glasses and other items will be needed supplement for a long time.

A. Hard hats must be usable in tight places.

B. Hearing protection, earmuffs (No soiled material into the ear)

C. Safety glasses, and face protection

D. Supplied air (preferably), or respirator. A respirator will not function in low oxygen, must be chosen for the right contaminant.

E. Safety belts, lifelines and lanyards.

F. Clothing, boots, gloves, etc. Fluorescent vests - attendants should be visible to all traffic at all times.

G. This list is indicative; individual conditions may require an appropriate choice of gear.

H. Lasers used only by trained workers (red color usual).

7. Safety Harness, Rope, Attendant

The safety harness and rope should be worn in the locations listed as hazardous. An attendant should be present even in the areas not listed, as pits less than 10 feet deep. A spare rope and harness should be available. Spare manpower and means of recovery should be provided.

8. Ladder

Adequate means of safe and rapid entrance and exit (egress) is needed. Ladders, whether permanent or portable should meet current specifications for the appropriate application.

9. Electrical

The presence of moisture in sewers and many plant processes makes good electrical practice a necessity. Proper grounding and bonding of the equipment precludes most of the chance for the worker to become a part of the circuit. The new generation of "ground fault interruptors" have an immediate wide application for this type of work. Solvents may be a problem.

Where vessels are entered usually within treatment and process plants, a lockout procedure is required to stop powered equipment.

"Explosion proof" equipment, usually Class 1, Division 1 is required for lights and power gear in certain locations..

Where power lines are encountered, buried or overhead, the electrical power company should provide the appropriate supervision and workers.

10. Tools and Work

Work carried out in a confined space may cause fumes or other conditions to change with time so that an awareness of the situation should be continuing throughout the job. Observed cases include the release of gases when a quiescent material was agitated, and the release of fumes when welding. Other hot processes are a problem source.

The new generation of "Ground Fault Circuit Interrupters" for personnel protection provides a new tool for safety in the typical sewer environment when power tools are used.

A. Need spark-resistant hand tools where an explosive level is probable.

B. Power tools may need to be Class 1, Division 1 or they may produce sparks to ignite fumes during use, regardless of electrical design. Consider the conditions involved in each problem situation.

C. Welding, cutting, brazing, soldering, heating. This may be an electrical hazard directly. Fumes from the metals used for the process may involve fluorides, as well as metals. Plating materials include lead, zinc, cadmium and others. Heated plastics, especially when scorched, release a host of fumes and should be avoided. A smell may be too much though odor may be a practical field test since laboratory grade evaluation is difficult and time consuming. These coatings may burn.

D. Solvents should ideally be swept out of sewer areas by the blower air. These should be reviewed for toxicity in the TLV tables, fire, and decomposition products.

11. Physical Agents

Several areas require comment, other agents may be a problem in special cases.

A. Noise is a problem if you have to shout to be heard by a fellow workman who is standing next to you. Measurements would be expected to confirm that noise from most jackhammers and large power drills is excessive for any but brief exposure. Personal protection would be indicated on all jobs of a temporary nature. Earmuffs would be suitable, hygiene problems make ear plugs undesirable on many jobs involving sewage.

B. Light should be adequate, without excess glare, and not be a fire hazard. The current application of lasers to construction alignment, etc., requires several cautions so the operator doesn't look directly at the light source. Some of the construction lasers are limited in power and type, but require good work practices.

C. Heat stress poses limits which can be read by instruments that measure a composite of temperature, humidity, radiant heat and airflow simultaneously (Wet Bulb, Globe Temperature).

12. Fire Protection

The main object to handle materials and work so that a fire does not ignite, should be followed up by knowing in advance the action to procure assistance from the fire department. Special problems affecting the fire fighting effort should also be considered in advance.

13. Personal Hygiene

Wash hands thoroughly before eating. This should be practiced regularly. Packing food in plastic bags in lunch boxes can be easily done to meet good practice.

Hand to mouth contact can also be made or avoided by the way a cigarette (if used) is handled. The simple, unconscious habit of touching one's lips, a nearly universal habit (look around in any friendly group), is most undesirable. These actions may be supervised, but are largely an action that has to be changed by the worker.

Sanitary facilities should be available, including the portable outhouse, if necessary.

This area should be extended after work by complete changes of clothes and a shower (include hair).

Potable water should be available.

14. Medical

Several areas are specified by OSHA. Good practice should provide continued maintenance of the capabilities needed.

A. First aid training and equipment for a relatively serious accident should be available immediately to every worker in the field as well as at the plant. This is well defined by OSHA regulations, but competent follow-up is indicated.

B. Physician and hospital access is a self-evident requirement for both field and plant workers. These are also defined by the OSHA regulation, and should be followed systematically.

C. Immunization and the physical condition of the worker are only two of several additional areas where a physician should be consulted for an adequate medical program. Tetanus immunization is one of the obvious shots to be given. Several others may be considered, especially in areas where special problems may exist. These actions should be taken before accidents happen.

Physical examinations should also be carried out under the direction of a physician.

Both of the above areas may be difficult to administer where the worker population involved is transient, and may not be fastidious. The problem of follow-up does, however, remain.

15. Housekeeping

Good housekeeping correlates with good safety records according to the consensus of most safety inspectors with whom we have had contact.

16. Final Checks

Supervision and workmen that make the "final check" of an installation need an extra bit of caution. Several of the SHL field studies involving a sewer accident were partially described as:

"He just went down for a last look"

"They went down to get blueprints left at the end of work"

It is recommended that supervision use the checklist provided in actual cases. Follow-up on detail through references can be made where indicated.

17. Accident Reports

When an accident has occurred (in spite of prior efforts) the first action is to provide for the victim, or patient. Follow-up is needed to provide information to prevent future accidents, hopefully learning from past mistakes. Legal and other records are also required. OSHA and IOSHA have provided avenues for such reporting.

All fatalities, major accidents, and report forms should be communicated to:

Commissioner of Labor
State Bureau of Labor
State Office & Laboratory Bldg.
East 7th & Court Streets
Des Moines, Iowa 50319

Phone: 515-281-3606

Module No:	Module Title: Manhole Safety Practices
	Submodule Title: Safety Practices
Approx. Time:	Topic: Safety Equipment

Objectives:

The student shall be able to identify, describe principles of operation and operate properly manhole safety equipment.

a. Safety harness
b. Self-contained breathing apparatus
c. Oxygen deficiency test meter
d. Combustible gas test meters
e. Toxic gas test meters
f. Detector tube test kits

Instructional Aids:

Safety equipment

Instructional Approach:

Discussion
Demonstration

References:

Manufacturer's literature

Class Assignments:

Observe demonstration
Participate in discussion

PERSONAL PROTECTIVE EQUIPMENT CHECKLIST - Handout #4

1. Safety toe shoes
2. Safety toe hip boots or chest waders
3. Safety hat (hard-hat)
4. Eye protection (glasses, goggles, shields, etc.)
5. Hearing protection (over the ear, muff type)

THE ABOVE ITEMS MUST BE OSHA APPROVED

Other suggested equipment for each collection system worker:

6. Raincoat - heavy rubber or rain-suit
7. Rubber gloves - short & long styles
8. Extra uniform or clothes

RESPIRATORY PROTECTIVE EQUIPMENT - Handout #5

I. Human Needs and atmosphere facts

A. Normal air contains 20.9% oxygen at sea level.

B. Oxygen content of air decreases as altitude increases.

C. 19.5% oxygen is minimum needed to support human life.

D. The following items will directly effect the amount of air needed by man.

1. The degree of physical activity
2. Physical condition
3. Emotional conditions

II. Respiratory Protective Equipment

A. Cannister type respirators

1. Use can containing filter or chemical to absorb contaminants in the atmosphere.
2. Not suitable for oxygen deficient atmospheres as they do not add oxygen to users air supply.
3. Each class or type of cannister is only suitable for specific types of contaminants.
4. Cannister type respirators are not recommended for use in manholes.

B. Compressed Air breathing apparatus

1. Self-contained breathing apparatus - user wears air supply tank on his person. Air supply can vary from as low as 5 minutes up to 45 minutes. Large tanks may be too heavy and bulky in manholes.

2. Supplied air breathing system - similar to SCBA except large supply tanks (1 to 6 hours supply) are used at remote location, and user is connected by air line. Escape bottles (5 to 10 minute supply) should be carried on the person in case main supply line is cut or main supply runs out.
3. General information (applies to both systems). Breathing apparatus will provide only respiratory protection and protection for facial areas covered by supply mask. It is best to select a breathing apparatus which will completely cover mouth, nose, and eyes. Deflectors should be mounted in the nose area of the mask to prevent fogging. Persons who wear eyeglasses should have lenses mounted in the mask to prevent leakage around the bows of the glasses. Also facial hair beards, long side burns and very long hair should not be worn by persons using breathing apparatus as leakage may occur.
4. Service life of compressed air cylinders may vary from manufacturers ratings due to following factors:
   a. Physical and emotional condition of user.
   b. Pressure in cylinder at start of use.
   c. Training and experience user has had with equipment.
   d. Presence of CO_2 (carbon dioxide) in air supply at levels greater than 0.4%.
   e. Atmospheric pressure, as pressure increases, duration decreases.
   f. Condition of apparatus.

Module No:	Module Title:
	Manhole Safety
	Submodule Title:
Approx. Time:	
1 hour	EVALUATION - Knowledge Skills

Objectives:

The students will answer at least 7 or 8 questions with complete accuracy on the written test.

1. List 5 of the seven common purposes for using manholes.

   a. _____

   b. _____

   c. _____

   d. _____

   e. _____

2. Sketch or describe the four common types of manholes.

   a. b.

   c. d.

3. List the six common dangers found in manholes.

   a. _____

   b. _____

   c. _____

   d. _____

   e. _____

   f. _____

4. Waist belt safety harnesses are acceptable for use in manholes.

   a. True _____

   b. False_____

5. MESA and OSHA approval are required for most safety equipment used in manholes.

   a. True_____

   b. False_____

Circle the best answer(s)

6. The use of blowers to ventilate manholes can be dangerous because

   a. They operate at high temperatures.

   b. They create excessive noise.

   c. Carbon monoxide may be introduced into the manhole.

   d. The blower may not have a high enough air delivery capacity.

7. Cannister type respirators are not acceptable in oxygen deficient manholes because

   a. They don't contain enough breathing air.

   b. They do not add oxygen to the breathing air.

   c. There is a danger of explosion when using them.

   d. They are only made for chlorine.

8. The most useful type of breathing apparatus for use in manholes is

   a. Cannister type respirator

   b. Self-contained breathing apparatus

   c. Air-line breathing apparatus

Module No:	Module Title:
	Submodule Title:
Approx. Time:	
	EVALUATION Practical Skills

Objectives:

The student shall be able to demonstrate the following skills, to the satisfaction of the instructor. The equipment will be provided by the instructor.

1. Put on a safety harness and show proper hookup and use of safety lines.
2. Put on, use, take off, and clean up a self-contained breathing apparatus.
3. Set up, calibrate, use, and interpret readings of the following test instruments.
   a. Oxygen test meter
   b. Combustible gas meter
   c. Toxic gas meter
   d. Detector tube kit